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This report documents the development of cargo flow forecasts for the Great Lakes System. These forecasts are the basis for a capacity evaluation of the existing locks. Economic feasibility of system-wide improvements are based upon NED benefits attributable to future cargo levels.

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FOR
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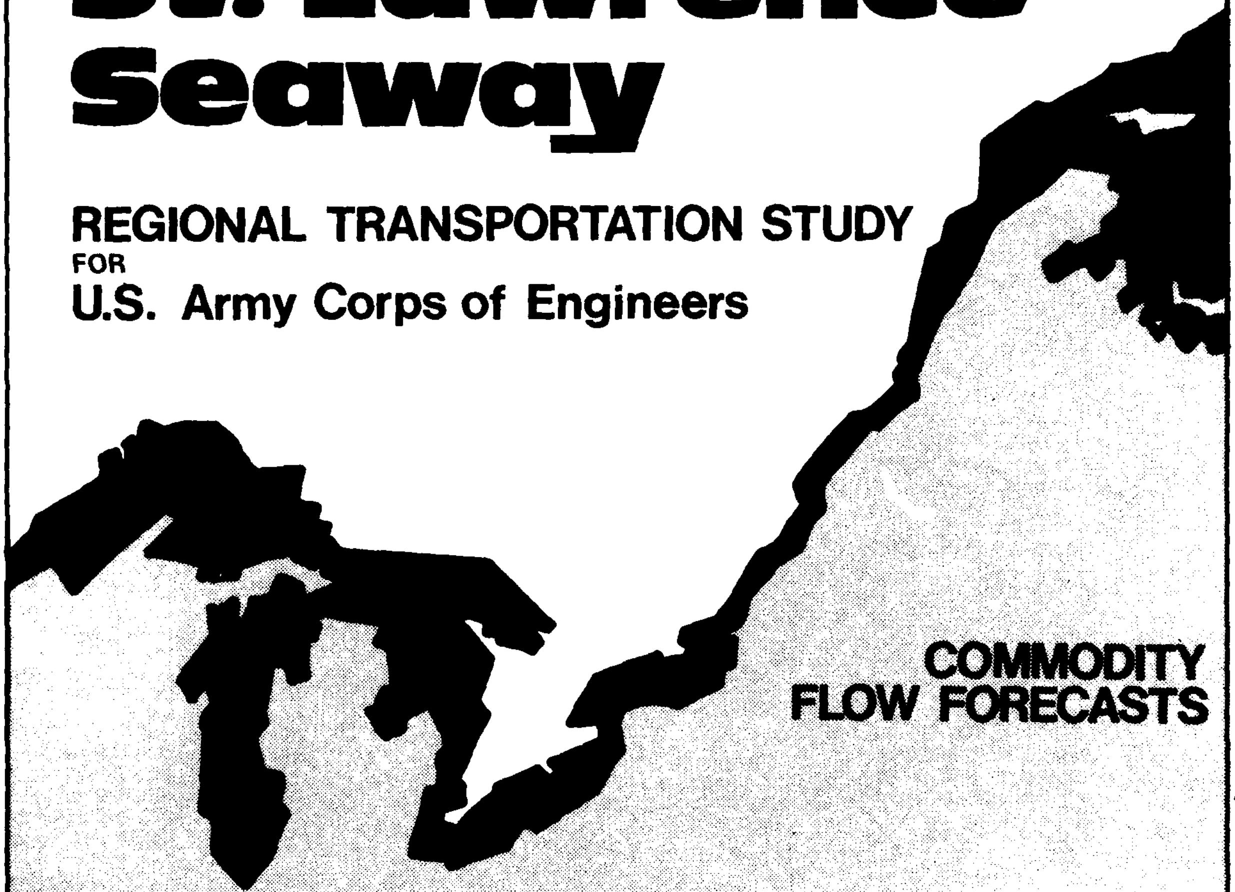

COMMODITY FLOW FORECASTS

BOOZ·ALLEN & HAMILTON INC.

IN ASSOCIATION WITH ARCTEC, Inc.

~~SEPTEMBER~~ NOV 1981

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GREAT LAKES/ST. LAWRENCE SEAWAY
REGIONAL TRANSPORTATION STUDY

COMMODITY FLOW FORECASTS

NOVEMBER 1981

for

U.S. Army Corps of Engineers

by

Booz·Allen & Hamilton Inc.
in association with
ARCTEC, Inc.

T A B L E   O F   C O N T E N T S

I. INTRODUCTION

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The U.S. Army Corps of Engineers is responsible for maintaining navigability in U.S. rivers, waterways, and harbors. The Corps currently maintains a navigation system of 25,000 miles of improved channels and 219 locks and dams connecting large regions of the country. Feasibility analysis and planning that precede lock and channel construction and maintenance are integral components of navigation system projects. The Great Lakes/St. Lawrence Seaway Regional Transportation Study is an element of this planning process.

The objective of the GL/SLS Regional Transportation Study is to develop an up-to-date, working analytical tool for economic analysis of GL/SLS transportation system improvements. The near-term uses of study information are feasibility studies of three Great Lakes navigation system improvements. These studies are the following:

- The St. Lawrence Additional Locks Study, which will determine the adequacy of the existing locks and channels in the U.S. section of the seaway in light of present and future needs.
- The Great Lakes Connecting Channels and Harbor Study, which will determine the feasibility of providing navigation channel, harbor and lock improvements to permit transit of vessels up to the maximum size permitted by the possible replacement locks at Sault Ste. Marie.
- The Great Lakes-St. Lawrence Seaway Navigation Season Extension Study, which considers the feasibility of means of extending the navigation season on the entire system.

The study is organized in two phases. Phase I has the following elements:

- Development of cargo flow forecasts for the Great Lakes system
- Development of data bases required for the evaluation of national economic development (NED) benefits and costs of navigation system improvements

- Evaluation of lock system performance and ability to process future cargo flows

- Evaluation of the performance and economic feasibility of improvements to increase the capacity of the system.

Phase II of the study assesses the regional economic, social, intermodal, and energy use impacts of alternative improvements.

This report documents the first element above, the development of cargo flow forecasts for the Great Lakes System. These forecasts are required to determine when the GL/SLS lock systems will reach capacity. The economic feasibility of system improvements will be evaluated based on the NED benefits attributable to their future cargo levels.

II. SUMMARY

II. SUMMARY

Forecasts of commodity flows using the Great Lakes/ St. Lawrence Seaway System were developed for a base year of 1978, and extended to the year 2050. Forecasts were prepared for the U.S. and Canadian movements of:

- Wheat
- Soybeans
- Barley
- Corn
- Sunflower seeds
- Limestone
- Iron ore
- Coal
- Pig iron, slag, steel scrap
- Petroleum
- Cement
- Nonmetallic minerals
- Other dry bulk
- Steel
- Non-steel general cargo.

For U.S. commerce (domestic, Canadian and overseas), detailed port-to-port forecasts were prepared. These port-to-port movements were then aggregated into lock forecasts (both upbound and downbound). For Canadian trade (Canadian domestic and overseas) forecasts were prepared only for lock movements in the Welland Canal, St. Lawrence Seaway and the Soo Locks.

This report describes the methodology followed to produce the commodity flow forecasts and describes the assumptions and data sources utilized. The remainder of the report contains the following chapters:

- Dimensions of the Forecasts

- Overview of Forecasting Methodology and Data Sources

- Methodology for Specific Commodities

- Benchmark Forecast Comparison.

A list of references follows these chapters. The appendix to the report presents the forecasts in tabular form.

III. DIMENSIONS OF THE FORECASTS

I.1 DIMENSIONS OF THE FORECASTS

The base year on which the forecasts are based is 1978. Base year traffic for U.S. shipments (domestic, U.S.-Canadian, and U.S.-foreign) was based on the dock-to-dock statistics of 1978 Waterborne Commerce of the United States.(1) Since complete port-to-port Canadian traffic (Canadian domestic and Canadian foreign) is not available from Statistics Canada, the 1978 Traffic Report(2) was used to identify this traffic by commodity, lock system and direction for the Welland Canal and St. Lawrence Seaway. Canadian traffic through the Soo Locks was taken from Statistical Report of Lake Commerce Passing Through the Canal at Sault Ste. Marie(3)

The base year dock-to-dock data contain traffic information for more than 2,000 U.S. Great Lakes docks. These data were aggregated to define traffic in terms of 40 major harbors; minor harbors are grouped into categories such as other Lake Ontario ports, other Lake Erie ports, etc. Port definitions are shown in Table III-1.

Forecasts were developed for 1985, and for every tenth year from 1990 to 2050. More resources were focused on the near-term projections to the year 2000 than on the long-term projections after 2000.

The forecasts contain details for 15 commodities or groups of commodities. Table III-2 shows the correspondence between these 15 commodity groups and Waterborne Commerce Statistics commodity codes.

In order to evaluate system capacity and benefits of capacity improvements, the detailed forecasts were converted to forecasts for each of the three lock systems--Soo, Welland and St. Lawrence. In addition, the forecasts were aggregated into the following commodity families, as shown in Table III-3:

- Grain
- Coal
- Iron ore
- Limestone
- Other bulk
- General cargo.

TABLE III-1
Port Definitions

Port Number*	Port	Waterborne Commerce Port Code	Location
1	Two Harbors	79297	Lake Superior
2	Duluth-Superior	79283, 79286	Lake Superior
3	Presque Isle	79077	Lake Superior
4	Marquette	79076	Lake Superior
5	Taconite	79321	Lake Superior
6	Silver Bay	79311	Lake Superior
7	Ashland	79245	Lake Superior
8	Green Bay	77825	Lake Michigan
9	Milwaukee	77690	Lake Michigan
10	Chicago (Navy Pier)	77647	Lake Michigan
11	Calumet Harbor	77641, 77642	Lake Michigan
12	Indiana Harbor	77632	Lake Michigan
13	Burns Harbor	77625	Lake Michigan
14	Muskegon	77562	Lake Michigan
15	Gary	77629	Lake Michigan
16	Escanaba	77875	Lake Michigan
17	Grand Haven	77567	Lake Michigan
18	Ludington	77535	Lake Michigan
19	Buffington	77631	Lake Michigan
20	Port Dolomite	76202	Lake Huron
21	Port Inland	77934	Lake Michigan
22	Port Washington	77702	Lake Michigan
23	Saginaw	76077	Lake Huron
24	St. Clair River	75014	St. Clair River
25	Detroit	73008-73013	Detroit River
26	Alpena	76133	Lake Huron
30	Toledo	72014	Lake Erie
31	Sandusky	72046	Lake Erie
32	Huron	72051	Lake Erie
33	Lorain	72060	Lake Erie
34	Cleveland	72073	Lake Erie
35	Ashtabula	72101	Lake Erie
36	Conneaut	72108	Lake Erie
37	Erie	72122	Lake Erie
38	Buffalo	72338, 72345, 72350	Lake Erie
39	Monroe	72007	Lake Erie
40	Fairport	72088	Lake Erie
41	Marblehead	72044	Lake Erie
42	Oswego	71184	Lake Ontario
43	Rochester	71039	Lake Ontario

* Appears in computer printouts.

TABLE III-1 (Continued)

Port Number*	Port	Waterborne Commerce Port Code		Location
60	Other U.S. St. Lawrence River	70000-70499	exc. as above	
61	Other U.S. Lake Ontario	71000-71499	exc. as above	
62	Other U.S. Lake Erie	72000-72499	"	
63	Other U.S. Detroit River	73000-73499	"	
		74000-74999	"	
		75000-75999	"	
65	Other U.S. St. Mary's River	78000-78499	"	(below locks - all docks except C. Reiss coal and Upper Canal pier)
66	Other U.S. Lake Huron	76000-76499	"	
67	Other U.S. Lake Michigan	77400-77999	"	
68	Other U.S. St. Mary's River	78000-78499	"	(above locks - C. Reiss coal and Upper Canal pier)
69	Other U.S. Lake Superior	79000-79499	"	
70	Canadian St. Lawrence River	70500-70999		
71	Canadian Lake Ontario	71500-71999		
72	Canadian Lake Erie	72500-72999		
73	Canadian Detroit River	73500-73999		
		74500-74999		
		75500-75999		
75	Canadian St. Mary's River	78500-78999		(below locks - all docks except Algoma Steel)
76	Canadian Lake Huron	76500-76999		
78	Canadian St. Mary's River	78500-78999		(above locks - Algoma Steel only)
79	Canadian Lake Superior	79500-79999		

* Appears in computer printouts.

TABLE III-2
Definition of Commodity Groups

Commodity	Waterborne Commerce Code
Wheat	0107
Soybeans	0111
Barley & Rye	0102
Corn	0103
Oilseeds	0119
Limestone	1411
Iron ore	1011
Steel scrap, slag, and pig iron	3311 3312 4011
Coal	1121
Petroleum	1311 29xx exc. 2920
Cement	3241
Nonmetallic Minerals	14xx
Other dry bulk	0104-0106 0112 10xx exc. 1011 14xx exc. 1411 2061 2920 3271 3313 4012
General Cargo (exc. steel)	0101-3324 exc. as noted elsewhere in this table; 34xx-9999 exc. 4011, 4012
Steel	3314-3317 3319

TABLE III-3
Commodity Detail for Forecasts

Forecast Level of Detail	Aggregation Used for Capacity Analysis
Wheat	Grains
Soybeans	
Barley	
Corn	
Sunflower seeds	
Limestone	Limestone
Iron ore	Iron ore
Coal	Coal
Pigiron, slag, steel scrap	Other bulk
Petroleum	
Cement	
Non-metallic minerals	
Other dry bulk	
Steel	General cargo
Non-steel general cargo	

The forecasts are unconstrained in the sense that it was assumed that locks, channels and harbors would be adequate to handle the projected traffic. In addition, resource constraints such as acreage or ore/coal deposits were not considered.

IV. OVERVIEW OF FORECASTING METHODOLOGY AND DATA SOURCES

IV. OVERVIEW OF FORECASTING METHODOLOGY AND DATA SOURCES

Various approaches were followed to estimate the forecasts for different commodities. For the major individual U.S. commodities moving on the GL/SLS system--wheat, corn, barley and rye, soybeans, iron ore, limestone and iron and steel products--stepwise multiple regression analysis was utilized. This procedure statistically relates the historical movements of the commodities on the GL/SLS with explanatory variables affecting the level of movements. Projections of these explanatory variables were then substituted into the established commodity regression relationship in order to project future GL/SLS movements of each major commodity. The total forecast movement was then allocated to individual U.S. port-to-port movements. For major port-to-port movements, actual shippers/receivers of the commodities were contacted as to the validity of these forecasts. Where differences occurred, the forecasts were adjusted.

The forecasting approach for coal was based on a survey of coal users. Each port-to-port coal movement was analyzed to determine if the receipts were to a utility, steel producer, or automobile producer. The largest movements from U.S. ports were generally to both U.S. and Canadian utilities located on the lakes. Each of these utilities was contacted, and actual forecasts of coal deliveries to each relevant plant were obtained.

Each of the remaining commodities was associated with the explanatory variable most likely to affect the movement of that commodity on the GL/SLS. Then variables were usually related to production levels of industries consuming the commodities. Projections of these explanatory variables by Bureau of Economic Analysis economic areas (BEAs) were obtained from the 1972 Series "E" OBERS projections developed by the Water Resources Council.(4) The receiving ports for each commodity were then associated with a BEA, and receipts of the commodities were estimated to grow at the corresponding BEA growth rate for the relevant explanatory variable.

The major Canada-Canada and Canada-foreign movements are wheat, barley and rye and iron ore. For Canadian grains, multiple regression analysis was used. Projections of the explanatory variables were then used to predict the total movement of the grains on the GL/SLS, which in turn were used to estimate future movements in the Soo Locks, Welland Canal and the St. Lawrence Seaway.

Forecasts of future iron ore consumption were obtained from the major Canadian steel producers. These data were used to project future Canada-Canada iron ore movements in the Welland Canal, Soo Locks and St. Lawrence Seaway. Finally, for the remaining Canada-Canada and Canada-foreign movements, each commodity or commodity group was associated with the explanatory variable most likely to affect shipments of that commodity. Exogenous growth projections of each of these explanatory variables were then used to estimate future commodity movements.

The basic forecasting parameters are shown in Table IV-1. The table identifies explanatory variables, the coefficient of determination (r^2), and the F-statistic, which defines the level of confidence associated with the regression equation.

Two types of data were used in the commodity projection analysis--historical and projected data. The historical data were used in estimating the regression models for the major commodities. A minimum of 12 years of time series data was used for each regression equation. The projected data were used in estimating the future growth of the explanatory variables and the subsequent commodity movements. The next chapter describes the forecasting methodology for each commodity and identifies the sources used to develop historical and projected data.

TABLE IV-1
Forecasting Parameters

Commodity	Explanatory Variables	Direction of Impact on GL/SLS Movements	R^2	F-Statistic
Iron ore	U.S. ore production	+	97%	53.9*
	GL/SLS ore consumption	+		
	Time trend variable	+		
Limestone	U.S. steel production	+	83	40.0*
	Limestone consumption	+		
Steel products	Steel imports	+	99	45.0*
	Construction employment	+		
	U.S. manufacturing	+		
	Inflation	-		
	U.S. steel production	-		
U.S. wheat	U.S. wheat exports	+	88	34.9*
	Stocks in hinterland	+		
U.S. corn	U.S. corn exports	+	92	34.5*
	Stocks in hinterland	+		
	Iron ore movements on GL/SLS	+		
U.S. barley and rye	U.S. barley & rye exports	+	94	71.7*
	Hinterland stocks			
Canadian wheat	Total Canadian exports of wheat	+	87	56.0*
	Stocks of wheat in Canada	-		
Canadian barley & rye	Total Canadian barley & rye exports	+	88	126.9*

* Overall equation significant at 95 percent level or above.

V. METHODOLOGY FOR SPECIFIC COMMODITIES

V. METHODOLOGY FOR SPECIFIC COMMODITIES

This section details the methodology, key assumptions and forecasts for each of the individual commodities and commodity groups.

1. U.S. GRAINS

Separate forecasts were prepared for:

- Corn
- Wheat
- Soybeans
- Barley and rye
- Sunflower seeds.

The approach for each is described below.

(1) System Forecasts

For corn, wheat, barley and rye, stepwise multiple regression analysis was used to statistically relate total exports via the GL/SLS to explanatory variables.

The most important explanatory variables for each grain commodity are:

- Corn - total U.S. corn exports from all port areas, corn stocks in the GL/SLS hinterland states and movements of iron ore on the GL/SLS (corn is a backhaul for upbound iron ore deliveries via Canadian lakers).
- Wheat - total U.S. wheat exports from all port areas and wheat stocks in the GL/SLS hinterland states.
- Barley and Rye - total U.S. barley and rye exports from all areas and barley and rye stocks in the GL/SLS hinterland.

For each grain type a variable was introduced to control for Pacific rim exports. However, this variable did not result in a statistically significant impact on GL/SLS grain movements. Therefore, the Pacific rim variable was not included in the "best fit" equations.

Historical data were taken from Source (5). Projections of the explanatory variables were obtained from Source (6). These projections were then substituted into the equation to estimate exports of each grain via GL/SLS ports.

No statistical equations were estimated for sunflower seeds because sunflower seed exports were negligible until only a few years ago. Sunflower seed movements were projected based on conversations with the Sunflower Association of America and the North Dakota Sunflower Exporters Council. Historical U.S. soybean exports could not be correlated with any combination of explanatory variables. Soybean exports were assumed to grow at the rate U.S. soybean production is projected to grow.(6)

(2) Key Assumptions

This section describes the key assumptions made in estimating U.S. grain forecasts. No projections of grain stocks by GL/SLS hinterland states were available. However, historical data (5) indicate that state shares of total U.S. stocks for wheat, corn, barley and rye remain fairly constant. Using these average historical shares for the respective grains, projections of GL/SLS hinterland grain stocks were computed from estimates of future U.S. grain stocks by type of grain.(6)

The regression models estimate future grain exports via the GL/SLS. Since about 90 percent of the total grain movements on the GL/SLS are exports, it was assumed that total movements of the specific grains would grow in proportion to export projections of each grain type.

Projections of agricultural activity were available only through 2005. After 2005, two growth scenarios were produced for each grain. In one scenario, stocks, production and exports were assumed to grow through 2050 at the rate projected for the 1990-2005 period. In the second scenario, stocks, production and U.S. exports were held constant after 2005.

(3) Port-to-Port Forecasts

Total exports of U.S. grains were allocated to port-to-port movements. For each major grain exporting port on the GL/SLS--Chicago, Duluth-Superior,

Milwaukee, Toledo and Saginaw--the average historical share of each port's grain movements (over a 12-year period) to total GL/SLS movements was estimated.(7) This historical share, by port, was compared to the actual 1978 share. If there was a significant difference between average and actual share, 1978 shipments for the port were adjusted to be consistent with average port share. The adjusted shipments were then used as the starting point for the forecasts. Actual 1978 shipments were entered into the forecast data base, however, so that consistency with *1978 Waterborne Commerce Statistics* would be maintained. The sum of the adjusted 1978 shipments was constrained to equal the sum of actual 1978 shipments.

After 1978, port shipment shares were assumed to remain constant. This assumption was made since there are insufficient data to estimate changes in relative port shares for a 70-year forecast horizon. Furthermore, the constant port share assumption was discussed with several major GL/SLS grain terminal personnel and was deemed to be a reasonable assumption. Finally, the overall GL/SLS estimated future growth rate for each grain type was applied to each adjusted 1978 port shipment tonnage (by grain type) to obtain port-to-port projections through 2050.

(4) Outlook for GS/SLS Grains

This section describes the outlook for grain movements on the GL/SLS. Each grain is discussed below.

Wheat movements are estimated to decline steadily through the year 2000. The reasons for this decline include the expected reduction of stocks of wheat and the increased use of unit trains moving GL/SLS wheat to Pacific ports.

Barley and rye movements are estimated to increase rather strongly through 2000, and then to stabilize as overall demand for U.S. barley and rye exports is expected to level off.

Corn exports are estimated to decline slowly through 2000, as hinterland stocks are reduced to low levels. However, after the year 2000, because of the projected increase in overall U.S. exports of corn and the strong growth in iron ore movements, corn exports via the lakes are expected to increase.

A slight decline in soybean movements is forecast through 1985 with a slow increase after that year, based primarily on forecasts of total soybean production.

Sunflower seed movements are assumed to grow fairly slowly, at about 0.1 percent annually. This estimate is based on conversations with the Sunflower Association of America, the North Dakota Sunflower Exporters Council and personnel from major grain terminals on the GL/SLS.

In conclusion, grain movements on the GL/SLS are expected to remain fairly stable, and even decline slightly, over the forecast period. This finding is consistent with the views of several individuals actively involved with the grain trade on the GL/SLS.

2. U.S. IRON AND STEEL RAW MATERIALS AND PRODUCTS

Separate forecasts were estimated for:

- Iron ore
- Limestone
- Iron and steel products

These are described below.

(1) System Forecasts

Multiple regression analysis was used to estimate the relationship between GL/SLS movements of each of the three commodities and explanatory variables. The explanatory variables found to affect statistically the movements of each commodity are:

- Iron ore - iron ore production in U.S. mines, iron ore consumption by the U.S. steel industry and a time trend variable. Specific variables to control for changing furnace type did not significantly affect iron ore movements and were not included in the "best fit" regression equation.

- Limestone - steel production in the GL/SLS states and limestone consumption by the U.S. steel industry.

- Iron and steel products - iron and steel imports from Europe, employment in constructon in GL/SLS states, value added

(constant dollars) in manufacturing in GL/SLS border states, price index of steel products and steel production in the GL/SLS states.

Historical data were taken from Source (8). Projections of the explanatory variables were obtained from Source (9). Substitution of the projected variables into the respective regression equations results in estimates of future movements of these commodities on the GL/SLS.

(2) Key Assumptions

Several key assumptions were made to forecast these commodities. These assumptions are described in this section.

The projected annual growth rate for the U.S. steel industry ws applied to 1980 GL/SLS hinterland raw steel production levels to estimate future GL/SLS hinterland raw steel production. This assumption was used for two reasons:

- More than 75 percent of the U.S. steel production occurs in the GL/SLS hinterland.
- No new major greenfield steel plants are foreseen, which suggests that the location of U.S. steel production will remain fixed.

Similarly, the projected growth rate for total iron ore consumption by the U.S. steel industry was applied to GL/SLS iron ore consumption by the GL/SLS steel industry. In 1979, 78 percent of the iron ore consumed by U.S. steel plants was from sources on the GL/SLS.

GL/SLS hinterland construction and durable manufacturing industries were assumed to grow at the U.S. average long-run rate of growth estimated for these industries. This is preferable to using regional forecasts which will reflect cyclical locational changes of the U.S. population over time, (i.e., urban to rural and vice versa), and which would distort the forecasts.

No specific forecast was available for limestone consumption. Therefore, historical data were used to estimate future limestone consumption. Limestone is used in the production of pig iron. The ratio of limestone to pig iron production was calculated over

time (8) and because of its constancy over time, the ratio was assumed to remain constant during the forecast period. Using this limestone to pig iron ratio, limestone consumption growth was estimated to parallel forecasts of future pig iron production.(9)

Finally, after 2000 it was assumed that steel production and pig iron production would continue to grow as it did between 1995 and 2000, since this latter period considers long-run changes in furnace composition. It was assumed that construction and durable manufacturing would grow after 2000 at the average 1980-2000 growth rate, in order to eliminate short-run business cycles prevalent in historical data for these industries.

(3) Port-to-Port Forecasts

The projected total GL/SLS movements of iron ore, limestone, and steel products were allocated to port-to-port movements in the following manner.

The major ports receiving each iron and steel raw material and product were identified. For each of the relevant ports, the shares of GL/SLS receipts for each iron and steel related commodity were computed for 1971-1978. The 1978 port share was then compared with the historical average share for each respective port. The 1978 port share was adjusted, if necessary, to reflect trends in the average historical share.

Each major receiving port was then associated with a steel producing district (as defined by the American Iron and Steel Institute). The 1978 adjusted port shares were projected to change relative to each other based on relative growth forecasts of the individual steel districts associated with each port.(9)

These future port shares were applied to overall GL/SLS projections of the relevant iron and steel related commodities to estimate future tonnage received at each port.

The projected port tonnage receipts, by commodity, were used to estimate future growth rates for receipts of the respective commodities at each port. The annual receipt growth rates, by port, were then applied to 1978 baseline port receipts in order to estimate future respective commodity receipts at that port from any given source.

For ports receiving only small amounts of a given iron and steel related commodity, receipts of that commodity, from all sources, were assumed to grow at the projected rate of overall growth for GL/SLS movements of that commodity.

Receipts of iron ore at Canadian ports were assumed to grow at the rate of iron ore consumption provided by the Canadian steel plants associated with each Canadian receiving port area.

(4) Outlook for Future Iron and Steel Related Commodities on the GL/SLS

In general, the movement of iron and steel raw materials and products on the GL/SLS are estimated to increase very gradually over the forecast period, primarily due to rather moderate growth projections of U.S. steel growth. The outlook for each commodity is described below.

Iron ore movements to U.S. destinations are projected to increase steadily, growing at an average rate of 1 to 2 percent per year. The ratio of tons of iron ore consumed per ton of steel produced is expected to decline from 0.93 in 1980 to 0.87 in 1990 and to 0.83 in the year 2000. This reflects the use of both electric furnace production and beneficiated iron ore.

U.S. shipments of iron ore to Canadian steel plants are also estimated to increase gradually over time. Similarly, projections of limestone movements closely parallel the growth in the U.S. steel industry. Limestone movements are estimated to increase at an average annual rate of about 1 to 2 percent per year. The ratio of domestic limestone shipments to domestic iron ore shipments is expected to remain fairly constant.

Steel product movements on the GL/SLS are primarily imports. These movements are estimated to increase dramatically between 1978-1985, as U.S. steel production increases, but does not keep pace with demand for steel. Imports are then expected to decline through 1995 as U.S. steel production continues to grow. Then, after 1995, steel imports are expected to increase gradually through 2050, as the U.S. annual inflation rate is reduced to about 4.0 percent and imports become more attractive with a more stable U.S. currency.

3. U.S. COAL MOVEMENTS

Coal movements were forecast directly on a port-to-port basis primarily using forecasts of coal receipts at utility plants that were prepared for each individual plant. The detailed methodology is described below.

(1) Methodology for Coal Forecasts

Utility plants using the GL/SLS were contacted for future projections of coal deliveries, including future sources. A list of utilities contacted is given in Table V-1. The survey included new or anticipated power plant additions. Each utility plant was associated with a port for receiving coal, and 1978 utility coal receipts versus the total port coal receipts, as reported in 1978 Waterborne Commerce Statistics, were compared. Where a utility accounted for all the coal deliveries at a port, the future utility projections were used to describe future coal receipts at that port from specific sources.

When a utility accounted for only a portion of a port's coal receipts, the sources of coal received at that port were identified from Waterborne Commerce Statistics. The utility's coal receipts via the port could be correlated with specific movements to that port. These utility related movements were then forecast according to the relevant utility's actual tonnage forecast, and source of future coal receipts.

For the ports not associated with a utility plant and for the ports with coal receipts in excess of the utility receipts, the following methodology was used to forecast coal movements:

- Each receiving port was associated with a Bureau of Economic Analysis area (BEA). Using OBERS projections of steel production in that BEA (auto production was used for the Detroit BEA) (4), all coal receipts to a port were assumed to grow in proportion to the relevant industry's growth in the attendant BEA.

- For coal receipts at minor ports included in categories such as "Other Lake Erie Ports," forecasts of coal movements destined for the given lake were used.

TABLE V-1
Utilities Contacted for Coal Forecasts

Utility	Plant	Lake Location/Port
Ontario Hydro	Lambton Plant	Canadian St. Mary's River
	Nanticoke Plant	Canadian Lake Erie
	Lakeview Plant	Canadian Lake Ontario
	R. L. Hearn Plant	Canadian Lake Ontario
Detroit Edison	Monroe Plant	Monroe Harbor, Michigan
	Trenton Plant	Trenton Harbor, Michigan
	River Rouge Plant	River Rouge, Michigan
	Connors Creek Plant	Connors Creek, Michigan
	Marysville Plant	Marysville, Michigan
	St. Clair Plant	St. Clair, Michigan
	Harbor Beach Plant	St. Clair, Michigan
	Belle River Plant	Harbor Beach, Michigan
	Fossil Plant Plant	Harbor Beach, Michigan
	Port Huron Plant	Marysville, Michigan
	Pennsalt Plant	Wyandotte, Michigan
Northern Michigan Electric Coop	Advance Plant	Charlevoix Harbor, Michigan
Niagara Mohawk	Huntly Plant	Port of Tonawanda, N.Y.
Holland Board of Public Works	James DeYoung Plant	Holland Harbor, Michigan
Upper Peninsula Power	Presque Isle Plant	Marquette, Michigan
Wisconsin Electric Power	Port Washington Plant Valley Plant	Port Washington Harbor, Wisconsin
Consumers Power	Cobb Plant	Muskegon Harbor, Michigan
Wisconsin Public Service	Pulliam Plant	Green Bay, Wisconsin

- For coal receipts at Canadian ports (from U.S. lake sources), the movement was associated with either Ontario Hydro or the Canadian steel industry. Forecasts of coal receipts from U.S. sources were obtained from Ontario Hydro. Coal receipts for the Canadian steel industry were assumed to grow at the rate predicted for Canadian steel production.(16)

(2) Outlook for Coal Movements on the GL/SLS

In general, it appears that coal movements will increase gradually on the GL/SLS system. Utilities indicated that coal deliveries to existing plants will generally remain constant or decline, as new fuel types (i.e., synfuels, nuclear, solar) are likely to replace coal after the year 2000. Most of the growth in shipments will result from new plants.

One of the major changes in Great Lakes coal shipments will be increased movement of western coal eastbound from Duluth-Superior. The survey of Great Lakes utilities identified three power plants that are or would be receiving western coal by water. Expected coal deliveries for these plants are shown in Table V-2.

TABLE V-2
Expected Western Coal Deliveries

Power Plant	Location	1978	1980	1985	1990	2000
St. Clair	St. Clair River	2,500	3,200	3,100	3,600	3,500
Belle River	St. Clair River	-	-	1,300	4,200	4,200
Harbor Beach	Lake Huron	-	-	-	-	9,300

Source: Detroit Edison.

Increased use of western coal does not appear likely at most other existing plants, as these plants are not equipped to burn lower sulfur, lower Btu western coals.

Ontario Hydro currently receives large amounts of Appalachian coal by water. Expected levels of future shipments are shown in Table V-3.

The reason for coal consumption decreasing during some time periods is that Ontario Hydro has three large nuclear generating stations coming on stream between 1982 and 1991. Each of the three projects will have 4 units coming into service over staggered time periods with total generating capacity of 8,960 megawatts. Ontario Hydro expects to continue receiving about 80 percent of its coal from its traditional Appalachian sources via the ports of Ashtabula and Conneaut.

TABLE V-3
Consumption of U.S Coal by Ontario Hydro

Year	Millions of Short Tons
1981	13.4
1982	15.4
1983	13.0
1984	12.9
1985	14.5
1990	10.7
1995	13.6
2000	16.1

Source: Ontario Hydro.

Conversations with coal exporters suggest that the long-term outlook for the use of the GL/SLS to export coal is unfavorable, primarily due to the shallow draft of the system compared to Atlantic and Gulf Coast ports and the subsequent extra costs involved in transshipping the export coal to larger vessels at St. Lawrence River ports. It is felt that the lakes in the future will act as a temporary outlet for export coal when bottlenecks occur at Atlantic and Gulf Coast ports.

4. PETROLEUM PRODUCTS

Port-to-port movements of petroleum products were identified from Waterborne Commerce Statistics. Receiving ports were associated with consuming BEAs, and it was assumed that port-to-port shares of total GL/SLS petroleum movements would remain constant during the forecast period.

Population was assumed to be the relevant explanatory variable, since fuel oil and gasoline are the primary petroleum products of interest. Hence, population would affect heating and electricity consumption as well as automobile use, in turn affecting the consumption of the petroleum products and their movements.

Petroleum receipts at U.S. ports were assumed to grow in proportion to population growth in the relevant BEA.(4) U.S. receipts at Canadian ports were assumed to grow in proportion to the Canadian population.(11) Receipts at minor lake ports were assumed to grow at the population growth estimated for the states bordering the relevant lakes.(4)

Petroleum products movements are estimated to increase overall, due to the gradual projected increase in population in the GL/SLS hinterland and in Canada.

5. CEMENT AND NONMETALLIC MINERALS FORECASTS

The explanatory variable most likely to affect cement consumption and hence movements on the GL/SLS is construction activity in the receiving port's surrounding hinterland. Similarly, since sand, gravel and gypsum are the major nonmetallic minerals and are also used in construction, construction activity is also assumed to affect movements of the nonmetallic minerals. Port-to-port movements of these commodities were identified from Waterborne Commerce Statistics. Each U.S. receiving port was associated with a BEA. Minor ports not identified individually were associated with states bordering the relevant lakes.

The receipts of nonmetallic minerals and cement at each of these ports were forecast to grow at the projected rate of growth of the construction industry for the BEA (or states) associated with each port.(4) Port-to-port shares of cement and nonmetallic minerals were assumed to remain constant, and hence no source changes were estimated. The constant source assumption is reasonable based on the fixed location of the cement, sand, gravel and gypsum reserves along the lakes.

Receipts of cement and nonmetallic minerals at Canadian ports from U.S. sources were assumed to grow in proportion to Canadian population growth(11), because Canadian construction projections were not available. This approach is reasonable since population is a factor affecting construction activity.

Overall movements of cement and nonmetallic minerals are estimated to grow rather slowly, due to fairly moderate growth in U.S. construction activity and Canadian population.

6. OTHER DRY BULK COMMODITIES

Port-to-port movements of other dry bulks were calculated from Waterborne Commerce Statistics. Imported coke is the major dry bulk commodity, and so each port was examined to determine if coke was a major receipt in 1978. For those ports receiving major coke tonnage, dry bulk movements were assumed to remain constant, as indicated by forecasts of future coke consumption by the U.S. steel industry.(9) Other U.S. ports were associated

with a BEA, and receipts of dry bulks handled at these ports were assumed to grow in proportion to the growth of general manufacturing for the respective port-served BEAs.(4)

For minor ports not identified individually, the states surrounding the relevant lakes were identified, and the growth rates of general manufacturing in these states were used to estimate dry bulk receipts. Canadian receipts of dry bulks from U.S. sources are estimated to grow in proportion to Canadian population growth estimates (11), since other Canadian forecast data were not available.

Overall, other dry bulk movements are estimated to grow rather slowly, primarily due to the fact that coke imports are expected to remain relatively constant.

7. GENERAL CARGO

General cargo refers to commodities that are distinguishable by "mark and count" techniques. General cargo as discussed in this section excludes iron and steel products, which were described in a preceding section. General cargo shipments on the Great Lakes differ fundamentally from shipments of most bulk cargoes in one key respect. The Great Lakes' "share of the market" of most bulk cargoes is quite high, in that the economies of routing via lakes is generally higher than an overland routing. For general cargo, however, the Great Lakes share of total imports and exports generated by the Lakes' hinterland states has traditionally been low. Only 1.0 to 1.5 percent of U.S. general cargo foreign trade (excluding steel) moves via Great Lakes ports.(12)

Therefore, when forecasting general cargo shipments, share is much more important than growth of the overall market. Great Lakes share cannot be predicted with any confidence by the statistical methods used to forecast bulk commodity traffic. Consequently, forecasts were formulated which were consistent with historical data and with expected developments in the competitive position of the Great Lakes system compared to the transportation infrastructure of other North American coasts. This process is described in the following sections.

(1) Historical Perspective

Almost all of the general cargo using the Great Lakes involves one U.S. port (and therefore is contained in U.S. trade statistics) and is overseas, not lakewise, trade. Table V-4 identifies U.S.

general cargo using the lakes for the past 12 years. During this time trade has remained in the 1 to 3 million ton range, and year to year fluctuations are not correlated with fluctuations in overall U.S. trade.

The general cargo situation on the Great Lakes was described in another technical report prepared during this study, "The Competitive Position of the Great Lakes for Containerized Cargo." The following conclusions are taken in part from that report:

- Current general cargo water service to the Great Lakes is inferior to service from other coasts in terms of sailing frequency, itinerary and transit time.

- Vessel size restriction, additional sailing time and shorter navigation season combine to inhibit carriers from establishing direct water service to the Great Lakes.

TABLE V-4
Great Lakes General Cargo
(Millions of Short Tons)

Year	Total	Excluding Steel
1968	8.0	2.09
1969	7.0	2.75
1970	6.5	1.58
1971	8.6	2.67
1972	7.9	2.76
1973	5.8	1.38
1974	4.5	1.09
1975	3.6	1.08
1976	4.5	1.50
1977	7.4	2.19
1978	5.7	2.12

Source: St. Lawrence Seaway Development Corporation (U.S. commerce only).

In view of the above, the number of scheduled liner carriers serving the Great Lakes has decreased from 43 in 1962 to 8 in 1980.

(2) Outlook

Several sources were reviewed to identify forecasts of Great Lakes general cargo. The two most relevant sources are discussed below.

- MarAd Long-Term Trade Forecasts.(13) Forecasts are on a trade route basis. For trade routes 32 (Great Lakes - UK/Europe) and 34 (Great Lakes - Mediterranean) general cargo was expected to increase by 4.7 percent per year. These two trade routes accounted for 66 percent of Great Lakes trade in 1978.

- The Great Lakes Transportation System.(14) Trend projections were produced which indicate growth in general cargo for the 1975 to 1985 period to be 2.1 percent per year. General cargo without iron and steel was expected to decline at 4.0 percent per year.

Two recently completed studies sponsored by the Maritime Administration were also reviewed. The "Great Lakes Traffic and Competition Study" does not contain trade forecasts. The trade forecasts used in the "Great Lakes Cooperative Port Planning Study" were obtained from the MarAd long-term forecasts identified above and did not differentiate between steel and non-steel general cargo.

Figure V-1 compares the general cargo forecasts with historical data. Figure V-2 makes the same comparison for non-steel general cargo.

Based on these data, a high* and a low projection for non-steel general cargo were developed. These are also shown in Figure V-2. The high scenario assumes that the two carriers which have recently terminated Great Lakes service (Manchester Lines and Polish Ocean Lines) will be replaced and that traffic will grow at about 1.3 percent per year. The low scenario reflects a continued degradation of service to the Great Lakes, and is slightly higher than an exponentially decreasing curve** fitted to the historical data.

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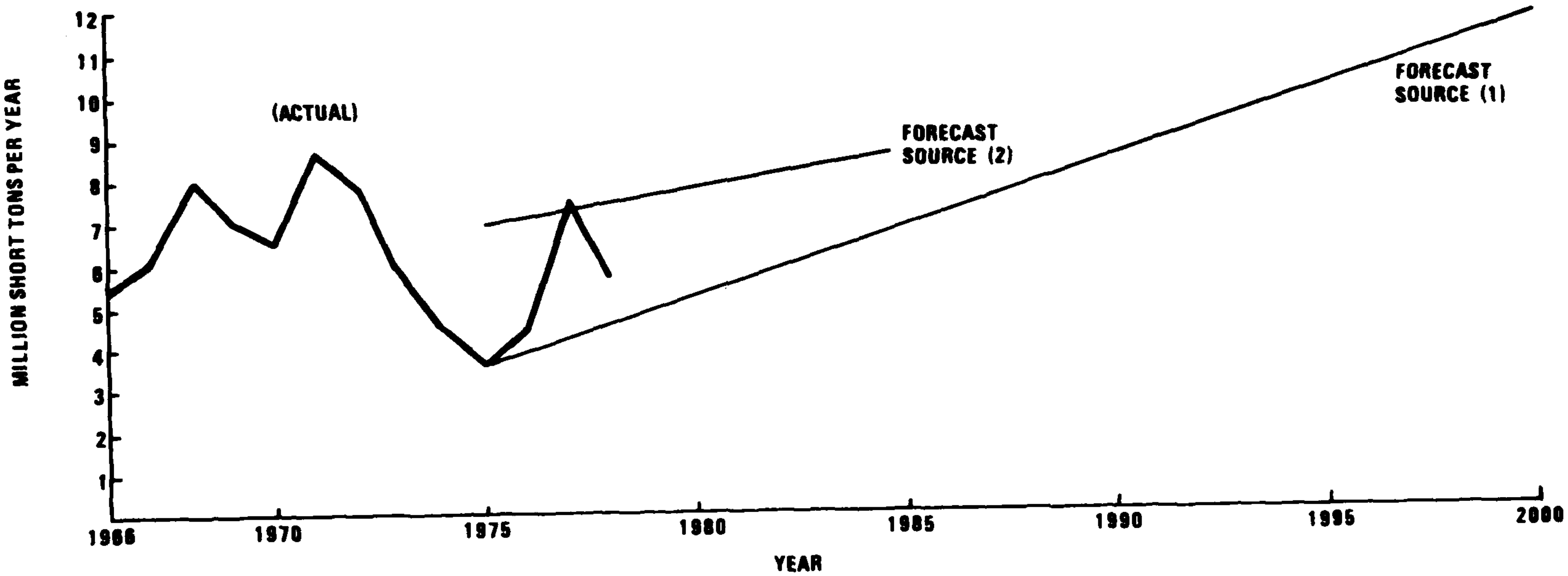
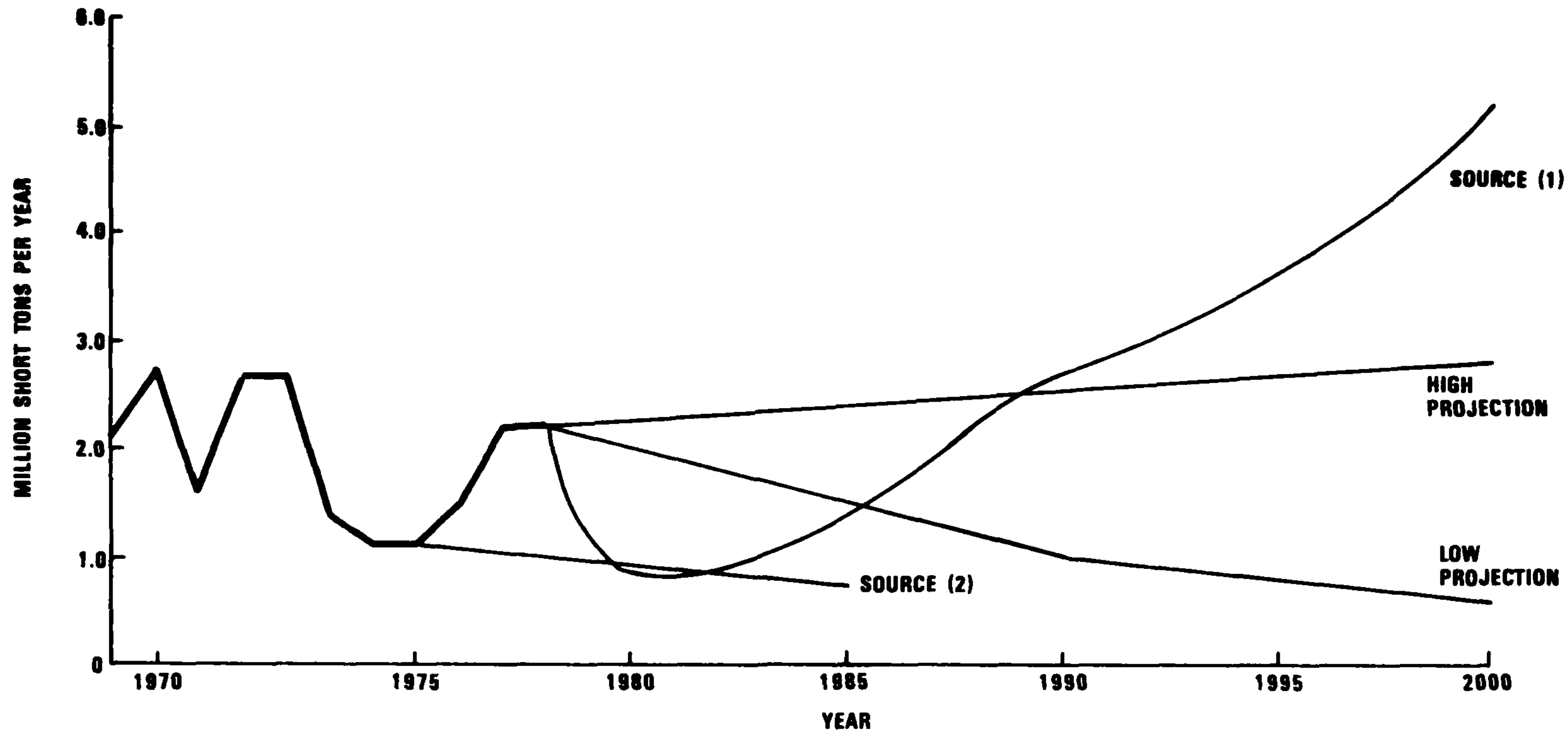
* Used for later capacity analysis.

** Of the form $y = T(r)^n$ where n is the year.



FORECAST SOURCES:
(1) MARAD LONG-TERM TRADE FORECASTS
(2) "GREAT LAKES TRANSPORTATION SYSTEM," UNIVERSITY OF WISCONSIN

FIGURE V-1
Great Lakes General Cargo (Including Steel)



FORECAST SOURCES:
(1) MARAD LONG-TERM TRADE FORECASTS (ADJUSTED BY SUBTRACTING BOOZ, ALLEN STEEL FORECASTS FROM TOTAL GENERAL CARGO PROJECTIONS
(2) "GREAT LAKES TRANSPORTATION SYSTEM," UNIVERSITY OF WISCONSIN

FIGURE V-2
Great Lakes Non-Steel General Cargo

8. OTHER IRON AND STEEL RAW MATERIALS

This commodity group consists of pig iron, slag, and iron and steel scrap. Port-to-port movements were calculated for each raw material from Waterborne Commerce Statistics. Individual port-to-port future movements were then estimated for each commodity as follows:

- Slag - receipts at a given port are assumed to grow in proportion to primary metals production in the surrounding BEA.(4)

- Pig iron - because of the rapid decline in GL/SLS pig iron movements since the late 1960s, 1978 tonnage is assumed to remain constant throughout the forecast period.

- Scrap - scrap movements by port are assumed to grow in proportion to the overall projected rate of scrap consumption in the steel districts bordering the GL/SLS.(9)

The overall growth of this commodity group is about 1.6 percent annually over the forecast period.

9. CANADIAN GRAINS

Separate forecasts were estimated for Canadian exports via the GL/SLS for wheat and barley and rye.

(1) Forecast Methodology

Multiple regression analysis was used to estimate the statistical relationship between Canadian exports via the GL/SLS and explanatory variables. The explanatory variables for each grain type are:

- Wheat - total Canadian wheat exports and the stocks of Canadian wheat

- Barley and Rye - total Canadian barley and rye exports.

In addition, a variable representing wheat exports and barley and rye exports to Pacific rim countries was included in earlier regression analysis, but was not statistically significant in affecting Canadian grain flows via the GL/SLS. Therefore, this variable was not included in the "best fit" regression equations.

Historical data and forecasts of the explanatory variables were obtained from Source (15). These forecast variables were substituted into the separate regression equations to estimate future GL/SLS tonnage of Canadian wheat exports and barley and rye exports. The tonnage projections were then used to estimate growth rates for each grain type. These growth rates were applied to the 1978 tonnage reported moving in the Soo Locks, Welland Canal and the St. Lawrence Seaway.

(2) Key Assumptions

Several key assumptions concerning the explanatory variables were necessary to project Canadian grain tonnage. These assumptions are described below.

Forecasts of total wheat exports were available only through 1985. Forecasts of total grain exports were available through 1990. The historical ratio of Canadian wheat exports to total Canadian grain exports has been fairly constant, at a ratio of about 0.67 (1970-1979 period). Assuming this ratio will hold during the forecast period, total future wheat exports through 1990 were estimated from projections of total grain exports. A high and low export projection was prepared based on forecast tonnage ranges. After 1990, wheat exports were assumed to increase by 1.0 percent annually, so as not to violate any acreage availability assumptions.

Wheat stock forecasts were also unavailable. Therefore, future Canadian wheat stocks were estimated using historical information. Historical data indicate that the ratio of Canadian wheat stocks to Canadian wheat production has remained fairly constant over time (about 0.60). Furthermore, the ratio of total wheat exports to wheat production has also remained fairly constant, and projections of grain exports and grain production indicate that this historical ratio (of exports to production) is expected to remain constant through 1990. Using the estimates of future total Canadian wheat exports and applying the constant ratio assumptions just described, future wheat stocks were estimated.

As with wheat, Canadian barley and rye total export projections were not available and had to be estimated using historical ratios. The ratio of barley and rye exports to total Canadian grain exports has remained constant over time at about 0.2. In

order to estimate future total barley and rye exports from Canada, this ratio was applied to estimates of total grain exports through 1990. High and low forecasts of total barley and rye exports were estimated, based on the forecast range of total Canadian grain exports. After 1990, total Canadian barley and rye exports were assumed to grow at 1.0 percent annually, so as not to violate any acreage constraints.

(3) Outlook for Canadian Grain Movements on the GL/SLS

Both barley and rye and wheat movements from the lakehead (Thunder Bay) are expected to increase strongly over time. The favorable forecasts result from expected improvements in transporting the grain from the farm to export ports and from the optimistic outlook for grain production and exports through 1990. For example, between 1979 and 1985 the Canadian Wheat Board estimates about a 10 percent annual increase in total Canadian grain exports.

10. CANADIAN IRON AND STEEL RAW MATERIALS AND PRODUCTS

The commodities in this group include iron ore, pig iron, steel scrap, coke, and steel products.

(1) Forecast Methodology

High and low forecasts of iron ore movements were prepared. The low scenario estimates are based on conversations with the officials of the two major Canadian steel producers, the Steel Company of Canada (Stelco) and Dominion Foundries (Dofasco), applied to 1978 iron ore tonnage through each lock system. The high scenario estimates were prepared as follows:

- Forecasts of Canadian steel production through 1985 (16), and U.S steel production through the year 2000 (9), were identified.

- A differential growth rate comparing the two was computed, so that forecasts of Canadian steel production through 2000 could be produced.

- This growth rate was applied to 1978 iron ore tonnage through each lock system. The traffic through each lock system was adjusted to account for sourcing shifts identified by Stelco and Dofasco.

Forecasts of other commodities in this group were based on growth rates for variables most likely to influence traffic.

(2) Key Assumptions

The near-term growth in Canadian steel production is more optimistic than that in the United States because of the modern plant in Canada, less regulatory requirements and overall lower production costs. After 1985, the differential between growth in the Canadian and the U.S. steel industries is expected to narrow as the relatively faster growth of the Canadian industry declines due to increasing costs and aging of capital equipment. In fact, by 1995 and for years after, the U.S. and Canadian steel industries are assumed to grow at an equal rate. This Canadian-U.S. growth differential is applied to long-run U.S. steel industry forecasts (after 1985) to estimate growth in the relevant sectors of the Canadian steel industry.

Canadian pig iron movements, like U.S. pig iron movements, are assumed to remain constant over time.

Canadian scrap movements are projected to grow at a rate equal to U.S. scrap consumption adjusted by the differential growth factors described above.(9) These growth rates were then applied to the 1978 Canadian tonnage in each lock system.

Canadian coke movements are estimated to grow according to the projected growth of U.S. steel production, and adjusted by the Canadian-U.S. differential growth factors.(9) Again, the projected annual growth rates were applied to the 1978 respective lock tonnages to estimate future Canadian movements of coke.

Iron and steel product movements in the Soo Locks, Welland Canal and St. Lawrence Seaway include imports and distribution of Canadian-made products. These are projected to grow at the rate of growth of Canadian industrial production.(9)

(3) Outlook for Canadian Iron and Steel Related Commodity Movements on the GL/SLS

The low scenario indicates that Canadian iron ore movements downbound through the Soo and Welland are estimated to decline through 1985, then increase strongly in 2000 due to a new Dofasco plant on Lake

Ontario scheduled to open in the year 2000. This plant will receive ore from Lake Superior. Upbound Canadian movements through the Welland are expected to increase during the forecast period due to the new Stelco plant on Lake Erie, which receives ore from Labrador. Similarly, upbound movements of iron ore from Labrador through the St. Lawrence Seaway are expected to increase from 1978 levels, primarily due to the new Lake Erie Stelco plant and major increases in Labrador iron ore consumption in 1990 by both the Dofasco and Stelco plants located on Lake Ontario.

The high scenario for iron ore indicates that Canadian iron ore movements will increase rather steadily over time at an annual rate of about 1.6 percent.

Canadian steel product movements are estimated to increase quite rapidly during the forecast period due to the 3.3 percent annual growth in Canadian industrial production.

Finally, coke movements are estimated to increase by about 2.5 percent annually, which is the average annual long-term growth projected for the Canadian steel industry.

11. OTHER CANADIAN COMMODITIES

Specific forecasts were estimated for Canada-Canada and Canada-foreign movements of:

- Petroleum products
- Cement
- Nonmetallic minerals
- Other dry bulks (excluding coke)
- General cargo.

It was assumed that these commodities or commodity groups would grow at a rate equal to estimated future annual Canadian population growth. (11) Since population is expected to increase, these commodities are also projected to increase through the lock system.

VI. BENCHMARK FORECAST COMPARISON

VI. BENCHMARK FORECAST COMPARISON

Other forecasting studies were reviewed to identify independent forecasts to which the commodity forecasts developed during this study could be compared. The only recent and publicly available study which forecast Great Lakes waterborne commerce on a commodities basis is the National Waterways Study (NWS) sponsored by the Corps of Engineers, Institute for Water Resources.* Figures VI-1 through VI-4 present these comparisons for grain, coal, iron ore and steel, respectively. Historical shipments for the period 1968 to 1978 are also shown in the figures. Note that the base year for NWS forecasts is 1977, while the base year for the forecasts for this study is 1978.

The two grain forecasts are similar through 1990; the Booz, Allen forecasts are significantly lower after 1990. This is due to the expectation that grain stock levels will decline and will depress corn and wheat exports.

The Booz, Allen forecasts for coal traffic are higher for domestic and lower for foreign traffic. These discrepancies could be because the volatile market conditions for coal may have changed over a year. In addition, the Booz, Allen forecasts were based on a survey of individual plants rather than on a forecasting technique.

The two iron ore forecasts are similar. The steel forecasts also agree except at 1985. The Booz, Allen forecasts are higher for this point, but by 1990 the two forecasts are almost identical. This could have been caused by use of different assumptions for the rate of inflation and for growth in GL/SLS manufacturing activity.

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* The National Energy Transportation Study does not treat coal shipments at the Great Lakes level of detail.

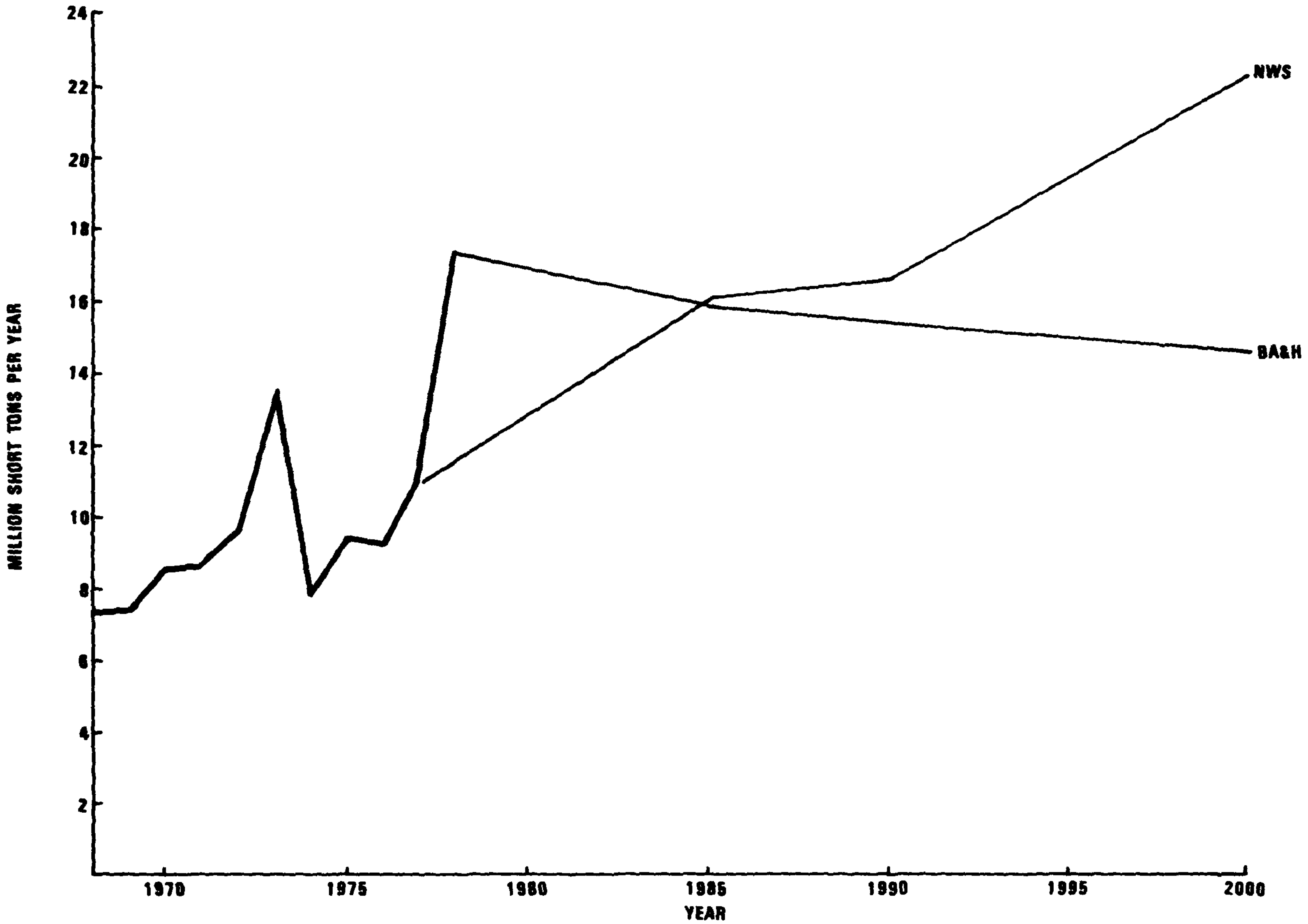

FIGURE VI-1
U.S. Grain Forecasts
(Foreign Trade)

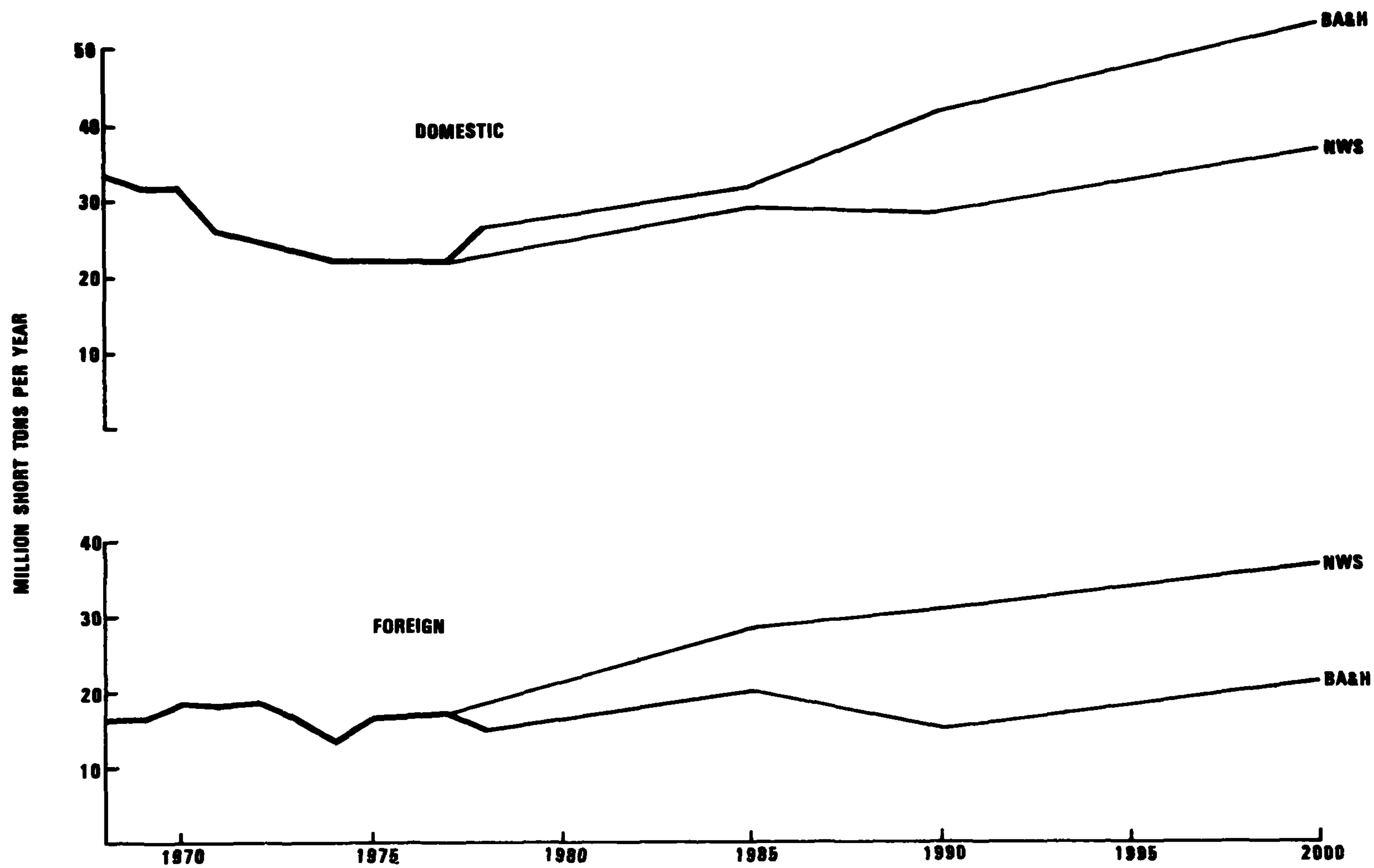

FIGURE VI-2
U.S. Coal Forecasts

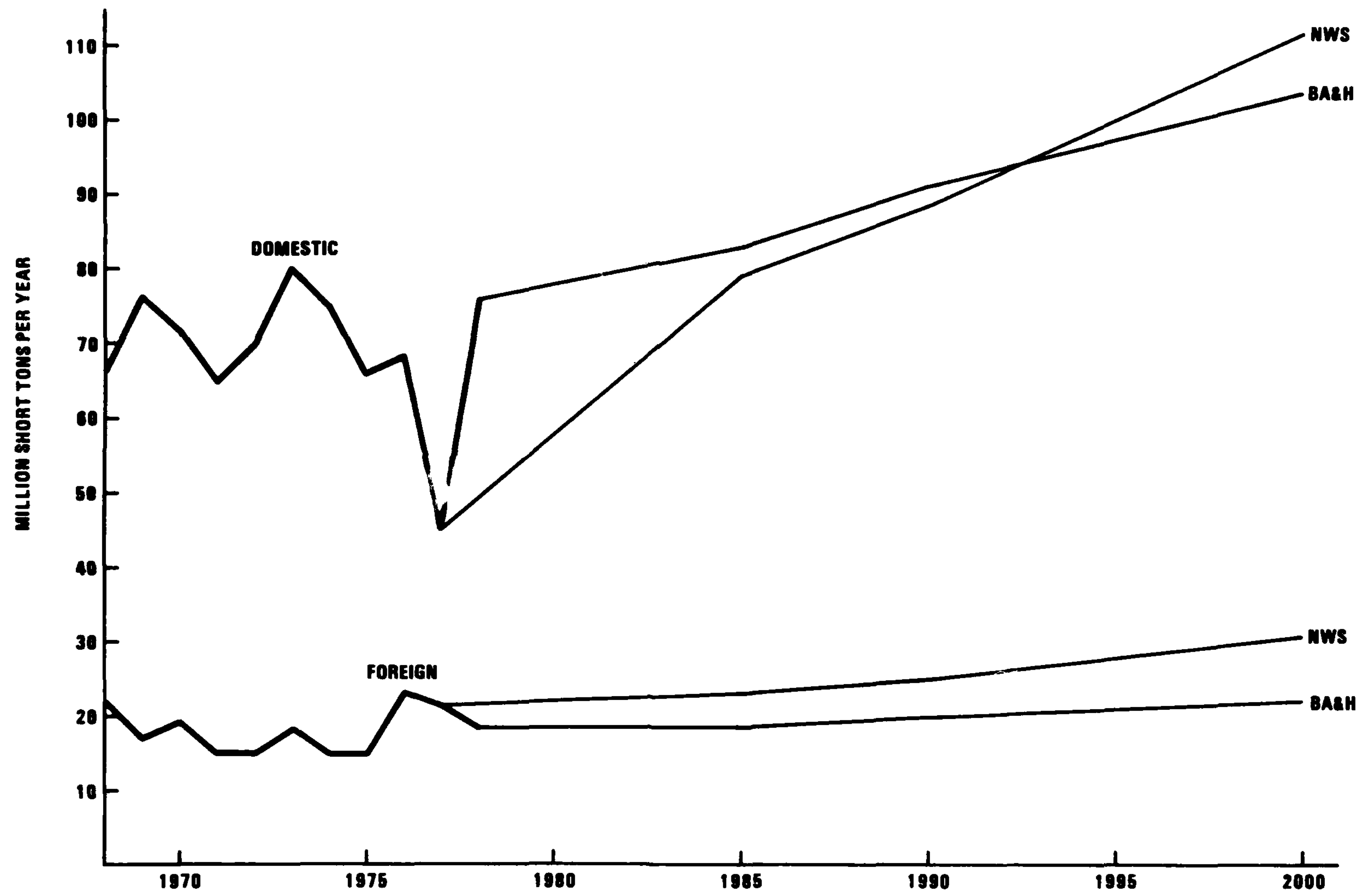

FIGURE VI-3
U.S. Iron Ore Forecasts

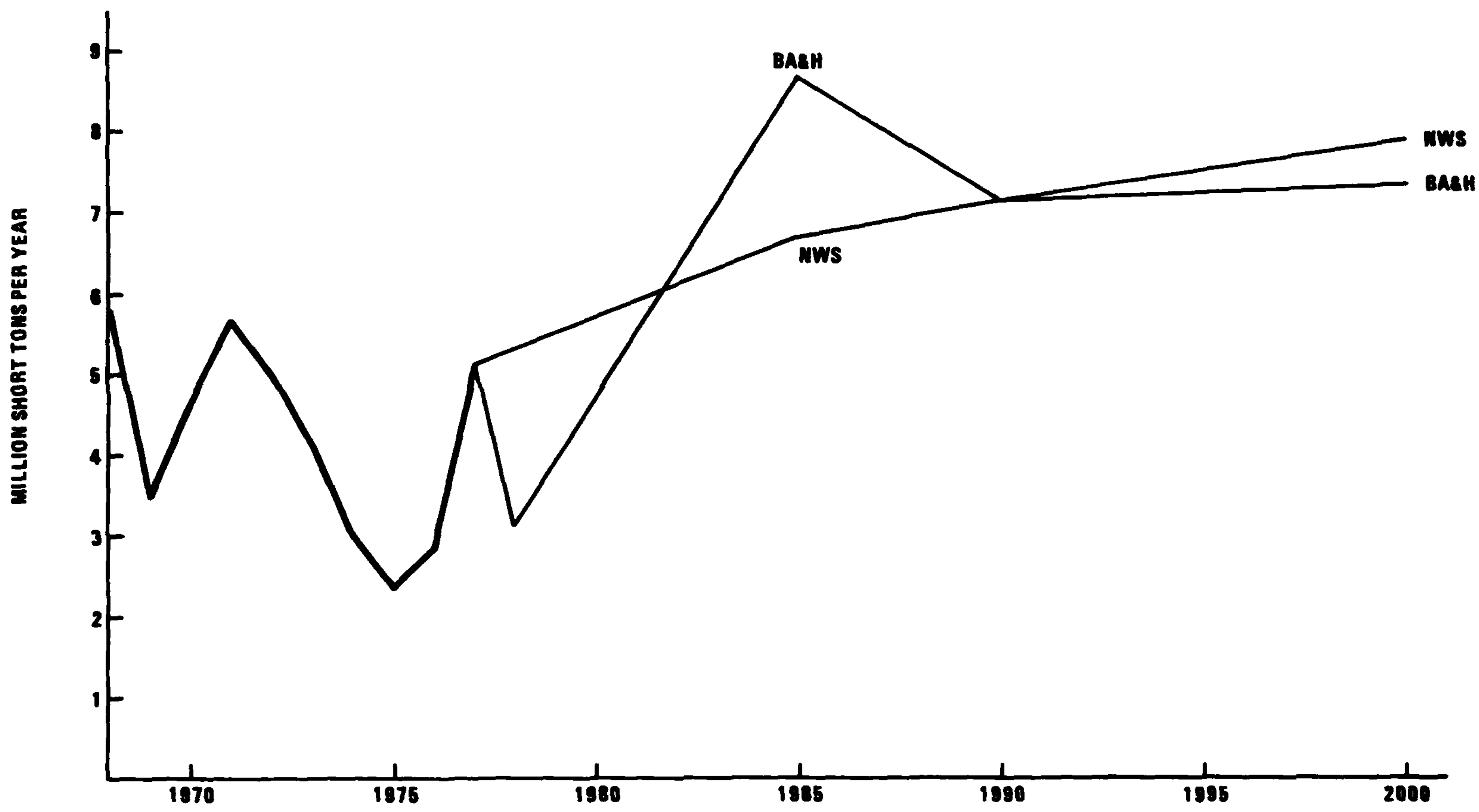

FIGURE VI-4
U.S. Steel Forecasts

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(11) Statistics Canada, Population Projections for Canada and Provinces, 1972-2001.

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(13) U.S. Department of Commerce, Maritime Administration, A Long-Term Forecast of U.S. Waterborne Foreign Trade, 1976-2000.

(14) E. Schenker, H. M. Mayer, and H. C. Brockel, The Great Lakes Transportation System, University of Wisconsin Sea Grant Program, Madison, Wisconsin, 1976.

(15) Canadian Wheat Board, various statistics.

(16) Gordon Securities Limited, The Canadian Steel Industry, November 1980.

APPENDIX

COMMODITY FLOW FORECASTS

TABLE A-1
St. Lawrence Seaway Traffic Forecasts
(Thousands of Short Tons)

DOWNBOUND	1978	1980	1985	1990	2000	2010	2020	2030	2040	2050
	****	****	****	****	****	****	****	****	****	****
IRON ORE	0	0	0	0	0	0	0	0	0	0
COAL	1	1	1	1	1	2	2	2	3	3
GRAIN	28745	30409	34570	37295	38816	42010	45153	49006	52841	57391
STONE	110	110	112	126	139	157	180	206	236	270
OTH BULK	5501	5708	6226	6939	8126	9491	11086	13094	15633	18915
GEN CARGO	1313	1374	1526	1611	1863	2174	2481	2962	3522	4199
	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****
	35670	37602	42435	45972	48945	53834	58902	65270	72235	80778
UPBOUND	1978	1980	1985	1990	2000	2010	2020	2030	2040	2050
	****	****	****	****	****	****	****	****	****	****
IRON ORE	13826	14451	16015	19873	20263	22495	24860	27389	30067	33016
COAL	1003	1029	1095	1161	1279	1411	1556	1715	1890	2084
GRAIN	6	7	8	20	23	25	25	25	25	25
STONE	46	47	49	55	62	69	80	90	103	119
OTH BULK	5301	5380	5576	5788	6201	6654	7185	7809	8545	9420
GEN CARGO	5592	7036	10647	9231	9861	11963	10648	15325	19459	23822
	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****
	25774	27950	33390	36128	37689	42617	44354	52353	60089	68486
TOTAL	61444	65552	75825	82100	86634	96451	103256	117623	132324	149264

TABLE A-2
Welland Canal Traffic Forecasts
(Thousands of Short Tons)

	1978	1980	1985	1990	2000	2010	2020	2030	2040	2050
DOWNBOUND	****	****	****	****	****	****	****	****	****	****
IRON ORE	4919	4901	4855	5418	5497	5895	6342	6846	7411	8045
COAL	5906	5823	5615	5155	5714	5718	5723	5729	5736	5744
GRAIN	29755	31481	35794	38696	40364	43645	46959	50965	54954	59682
STONE	110	110	112	126	139	157	180	206	236	271
OTH BULK	6333	6562	7136	7868	9119	10556	12277	14295	17053	20466
GEN CARGO	1114	1165	1292	1345	1530	1763	1973	2323	2714	3166
	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****
	48137	50042	54804	58608	62363	67734	73454	80364	88104	97374
UPBOUND	1978	1980	1985	1990	2000	2010	2020	2030	2040	2050
	****	****	****	****	****	****	****	****	****	****
IRON ORE	11148	11391	12000	13383	15309	17544	19911	22445	25125	28078
COAL	0	0	0	0	0	0	0	0	0	0
GRAIN	6	7	8	20	23	25	25	25	25	25
STONE	46	47	49	55	62	69	80	90	103	119
OTH BULK	3864	3939	4125	4331	4757	5148	5684	6390	7271	8621
GEN CARGO	4792	6209	9750	8250	8711	10621	9069	13454	17221	21117
	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****
	19856	21593	25932	26039	28862	33407	34769	42404	49745	57960
TOTAL	67993	71635	80736	84647	91225	101141	108223	122768	137849	155334

TABLE A-3
Soo Locks Traffic Forecasts
(Thousands of Short Tons)

	1978	1980	1985	1990	2000	2010	2020	2030	2040	2050
DOWNBOUND	1978	1980	1985	1990	2000	2010	2020	2030	2040	2050
	****	****	****	****	****	****	****	****	****	****
IRON ORE	67699	69216	73007	80554	90495	104196	118656	134166	150710	168055
COAL	2846	3372	4685	11702	17338	19749	17951	17991	18036	18085
GRAIN	23857	25832	30769	34886	35279	38125	40986	44558	48137	52416
STONE	0	0	0	0	0	0	0	0	0	0
OTH BULK	1961	2024	2182	2354	2735	3173	3684	4281	4980	5804
GEN CARGO	833	854	907	959	1068	1192	1326	1482	1655	1848
	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****
	97196	101298	111550	130455	146915	166435	182603	202478	223518	246208
UPBOUND	1978	1980	1985	1990	2000	2010	2020	2030	2040	2050
	****	****	****	****	****	****	****	****	****	****
IRON ORE	178	183	197	224	254	292	332	375	425	478
COAL	4817	5313	6551	5418	6858	7511	8238	9045	9942	10939
GRAIN	0	0	0	0	0	0	0	0	0	0
STONE	1995	2013	2060	2307	2543	2884	3302	3780	4328	4955
OTH BULK	2475	2553	2749	2953	3471	4063	4782	5654	6718	8017
GEN CARGO	736	764	833	854	943	1056	1141	1303	1469	1651
	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****
	10201	10826	12390	11756	14069	15806	17795	20157	22882	26040
TOTAL	107397		123940	142211	160984	182241	200398	222635	246400	272248

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